# Michio MASUDA*: **Taxonomic notes on *Rhodophysemopsis* gen. nov. (Rhodophyta)**

# 増田道夫*: 紅藻類の一新属フチトリベニモドキ属について

Denizot (1968) revised the genus *Cruoriopsis* Dufour (Cruoriaceae, Gigartinales) comprising twelve species at that time and made the following transfers. The type species, *C. cruciata* Dufour was transferred to *Cruoriella* and reduced to synonymy with *Cruoriella armorica* Crouan frat., type species of the latter genus. *Cruoriopsis de-zwaanii* Weber van Bosse, *C. japonica* Segawa, *C. maris-rubri* Rayss et Dor, *C. mexicana* Dawson and *C. rosenvingii* Børgesen were also transferred to *Cruoriella* and the last species was reduced to synonymy with *Cruoriella armorica*. *Cruoriopsis gracilis* (Kuckuck) Batters was retransferred to *Plagiospora*, revived at that time. However, the taxonomic status of other five species have remained unsolved, although he pointed out that *Cruoriopsis ensisae* Jao and *C. hauckii* Batters have affinities with *Rhodophysema* and *Plagiospora*, respectively. On the other hand, Hollenberg (1970) described *Cruoriopsis aestuarii* after Denizot's work. The generic name *Cruoriopsis* should be rejected, according to the International Code of Botanical Nomenclature (Stafleu, 1972). Six species left in '*Cruoriopsis*' form a heterogenous assemblage and so it is impossible to circumscribe a genus comprising them.

In these six species only tetrasporangial plants have been detected in the field. Recent culture experiments demonstrated that several crustose species for which only tetrasporophytes are known represent the tetrasporophytic phase of macroscopic algae for which only gametangial and carposporangial phases are known (Dixon *et al.*, 1972, for review; South *et al.*, 1972; West, 1972). According to Edelstein (1970), the crustose tetrasporophyte of *Gloiosiphonia capillaris* resembles *Cruoriopsis hauckii*, but this is not confirmed. On the other hand, Ganesan and West (1975) and Fletcher (1975) reported the life history with only a tetrasporophyte in laboratory

---

* Department of Botany, Faculty of Science, Hokkaido University, Sapporo, Hokkaido. 北海道大学理学部植物学教室

culture experiments for *Rhodophysema elegans* and *R. georgii*, respectively. These results suggest strongly a possibility that there exist other crustose algae with only the tetrasporophyte, in addition to species with the *Polysiphonia*-type of life history. My recent collection of a crustose alga from Hokkaido, Japan, made it possible to determine the taxonomic relationship between this alga and one of '*Cruoriopsis*', *C. hyperborea* Rosenvinge.

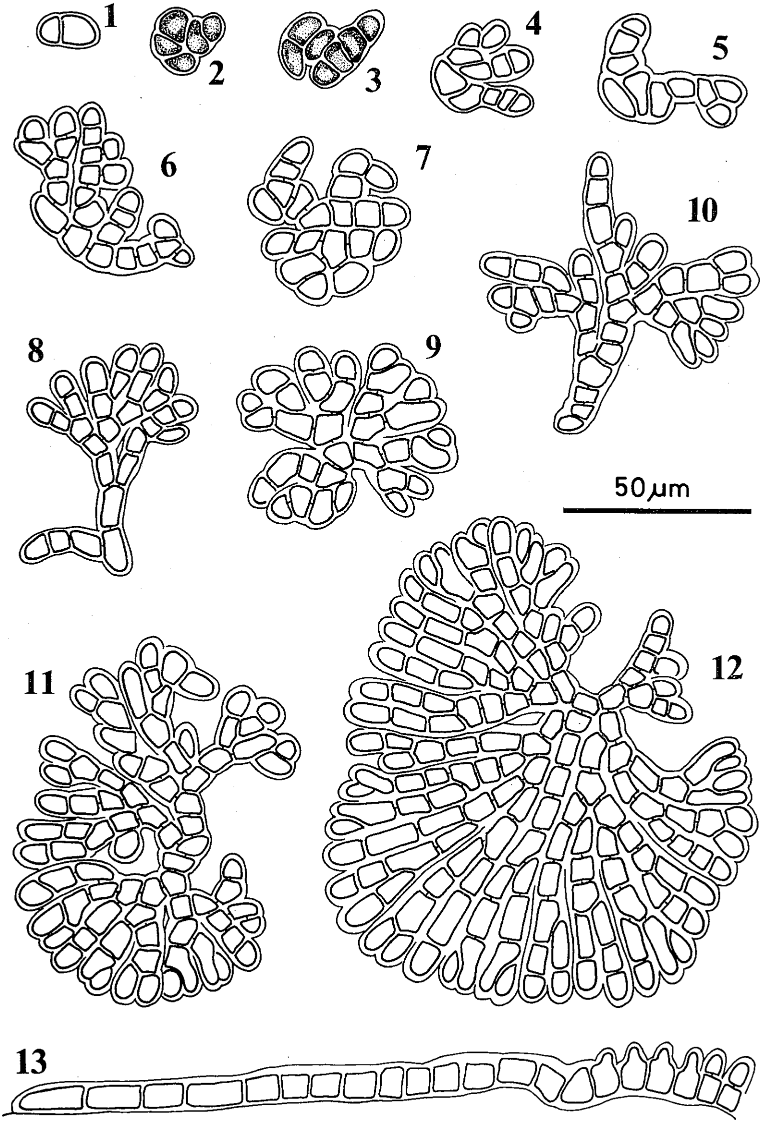
I wish to express my sincere thanks to Prof. M. Kurogi, Hokkaido University, and Prof. P. S. Dixon, University of California, for their criticism of the manuscript, and Prof. H. Toyokuni, Asahikawa University, for his preparation of the Latin description as well as for his invaluable advice. Thanks are also due to the staffs of the Nemuro Fishermen's Cooperative Association for their kind help in collecting the material.

This work was partially supported by a grant from the Ministry of Education, Japan.

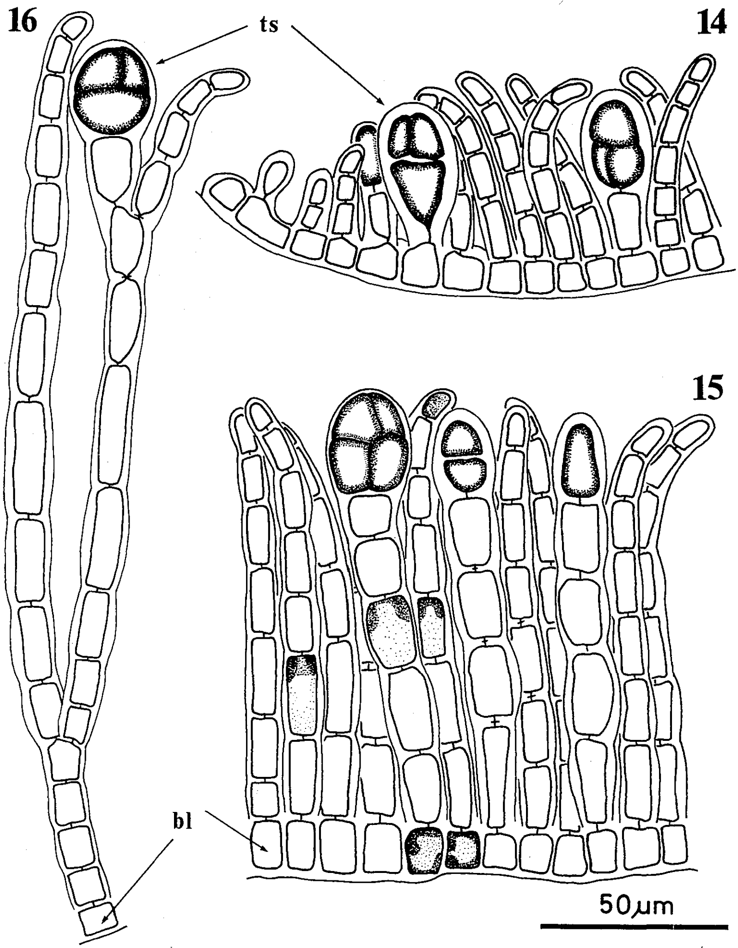
**Materials** The specimens examined were collected at Hanasaki, east coast of Hokkaido, growing on the stipe of *Laminaria coriacea* cast ashore, on June 25, 1975. They were fixed and preserved in 10% formalin in seawater. Voucher specimens (indicated by specimen numbers *Masuda* 14034-14041) and slides are deposited in the herbarium of Faculty of Science, Hokkaido University, Sapporo (SAP).

**Observation** This alga grew abundantly on the stipe of *Laminaria coriacea* and its various growing stages, very young germlings to adult plants, were observed on the same host plant. Young germlings could be identified by their color, the nature of the chloroplast and the size of the cells. The developmental sequence of the alga can be traced by an examination of the germlings.

Spores, which are perhaps tetraspores, judging from the absence of carpogonia and carposporophytes, as will be noted later, at first divide into two cells (Fig. 1). Successive divisions occur irregularly in each cell and give rise to a filamentous germling which is irregular in shape and divides pseudodichotomously. Germlings grow in various directions, showing a variable shape (Figs. 2-10). As growth advances, the filaments form a rather aggregate, monostromatic crust-like system (Figs. 11-12). Original cells of the erect filaments are produced by cell divisions parallel to the substratum, at first arising from the cells at the central portion of the basal creeping



Figs. 1-13. Young plants of *Rhodophysemopsis laminariae*. 1-12. Various developmental stages of the basal layer in surface view. 13. Tangential section of a young plant, showing the monostromatic basal layer and initial cells of the erect filaments.



Figs. 14–16. Tangential sections of three tetrasporangial plants in *Rhodophysemopsis laminariae*. 14. Marginal portion of a thin plant. 15. Central portion of a moderately thick plant. 16. Branched erect filament of a very thick plant. ts, tetrasporangium; bl, basal layer.

system (Fig. 13). Successive cell divisions parallel to the substratum result in uniseriate erect filaments. Concurrently with this growth, cell divisions parallel to the substratum extend toward cells of the periphery.

Mature plants are dark red in color and circular to elliptical in shape,

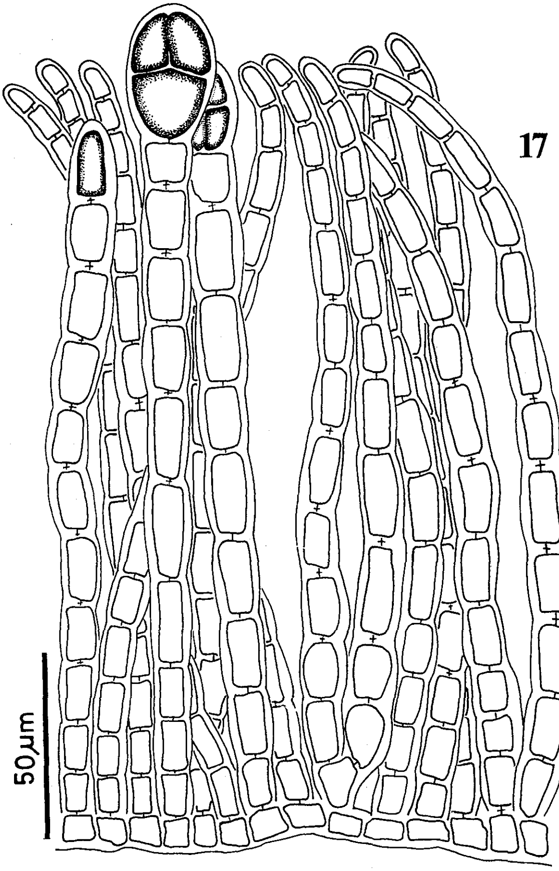
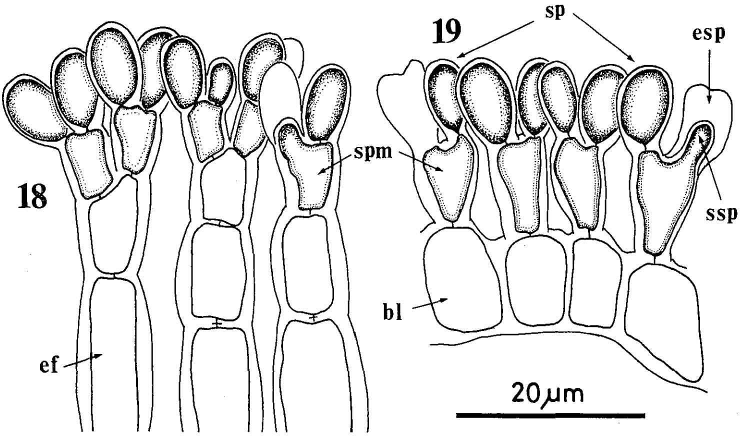


Fig. 17. Tangential section of a very thick tetrasporangial plant in *Rhodophysemopsis laminariae*.

measuring 0.5-2.0 mm in diameter and 70-240 μm thick in the fertile portion. They are one cell thick at the growing margins. The erect filaments are usually simple and composed of 1-13 cells, but occasionally branch one or two times (Figs. 16-17). Their nodes are somewhat constricted (Figs. 15-18). The sterile filaments of tetrasporangial plants are slightly slenderer than the fertile filaments. The former filaments are mostly 7.5-11.5 μm broad, while the latter ones are 10.0-15.0 μm broad (Figs. 14-17). Erect filaments of the thallus are not enveloped by a common wall or any gelatinous matrix and are held together loosely by mucilage (Figs. 14-15, 17-19).

Tetrasporangia and spermatangia have been observed on fertile plants, respectively, but carpogonia and carposporophytes have not been detected, although one hundred or more plants have been examined. Tetrasporangial initials are borne on the terminal ends of unbranched erect filaments which are slightly broader than sterile ones (Figs. 14-17). Sometimes they are formed terminally on the lateral branchlets (Fig. 16), and directly from the cells of the basal layer (Fig. 14). Sterile filaments bend downward when tetrasporangial plants reach reproductive maturity (Figs. 14-17). These curved filaments resemble paraphyses of *Rhodophysema*. The tetrasporangial initials are easily distinguishable from other cells by their dense contents. The first division of the sporangia takes place horizontally. The second and third divisions occur at right angles to the first, resulting in cruciate sporangia (Figs. 14-17). Mature tetrasporangia are ellipsoid and measure 32.5-45.0 μm long and 17.5-25.0 μm in diameter.

As the carpogonial and cystocarpic plants are apparently absent, the structure termed here spermatangia may only be assumed by analogy with



Figs. 18-19. Tangential sections of two spermatangial plants. 18. Central portion of a very thick plant. 19. Marginal portion of a thin plant. sp, spermatangium; spm, spermatangial mother-cell; esp, empty spermatangium; ssp, secondary spermatangium; ef, erect filament; bl, basal layer.

similar structure as in cases of *Palmaria* (Guiry, 1974), *Halosaccion* (Lee and Kurogi, 1968) and *Rhodophysema georgii* (Masuda and Ohta, 1975). Spermatangial mother-cells are produced usually two or rarely one from almost all terminal cells of the erect filaments (Fig. 18). They are rarely produced directly from the cells of the basal layer (Fig. 19). Each mother-cell bears usually two spermatangia (Figs. 18-19), but rarely one spermatangium. Spermatangial mother-cells are indistinguishable from vegetative cells before formation of the spermatangia, but they become slightly yellowish in color as spermatangia develop. Mature spermatangia are ellipsoid and almost colorless, measuring 8-9 μm long and 5-6 μm in diameter. Sometimes secondary spermatangia are formed within the empty spermatangial wall (Figs. 18-19).

**Discussion** The female gametangial plant of this alga has not been detected, but its tetrasporangial and male gametangial plants are abundantly present. Two possible life histories of this alga may be considered: (1) the female gametophyte exists as a phase similar in morphology to the known tetrasporophyte and male gametophyte (the *Polysiphonia*-type); (2) the female gametophyte is absent and the division of the tetrasporangium may be apomeiotic as in the Japanese *Rhodophysema georgii* (Masuda and Ohta, 1975). In either case, it is certain that the alga under discussion does not represent to be a phase in the life history of another alga and is an independent taxon.

This alga is characterized by its thallus structure, namely, the nature of the structure of the erect filaments. The erect filaments are not enveloped by a cuticle or gelatinous matrix and they are loosely adjoined only by mucilage. This feature strongly distinguishes this alga from the majority of crustose red algae. In addition to this principal feature, only a few other species seem to have the following characters similar to this alga: (1) the hypothallus lacking rhizoids, and (2) tetrasporangia formed terminally on erect filaments. These species are *Rhodophysema minus*, *Cruoriopsis ensisae* and *C. hyperborea* mentioned below.

*Rhodophysema minus* established by Hollenberg and Abbott (1965) on the basis of material from California, North America, resembles this alga so far as their illustration shows (Hollenberg and Abbott, 1965, p. 1180, Fig. 9; 1966, p. 57, Fig. 20). In *R. minus* the lower portion of sterile erect filaments (paraphyses) and the lower sterile portion of tetrasporangiferous filaments, both of which constitute the sorus, are rather more loosely united than those of any other *Rhodophysema* species. In *Rhodophysema georgii* (Rosenvinge, 1917; Tokida, 1934; Kylin, 1944; Masuda and Ohta, 1975; Fletcher, 1975) and *R. elegans* (Rosenvinge, 1917; Hollenberg and Abbott, 1966; Ganesan and West, 1975), the vegetative portions of erect filaments including sterile filaments, whose upper portions grow into paraphyses, and tetrasporangiferous ones cohere to form a distinct perithallus, and by this character *Rhodophysema* is clearly distinguished from the alga under discussion. The mode of spore development of *R. georgii* and *R. elegans* is of the immediate discal type, termed by Inoh (1947), or the Chemin's *Dumontia* type (Chemin, 1937) as reported by Masuda and Ohta (1975), Fletcher (1975), and Ganesan and West (1975), whereas that of this alga is of the diproto-cellular type (Inoh, 1947) or the *Naccaria* type (Chemin, 1937). This difference is a basic criterion for taxonomic discrimination from the morphogenetic point of view.

On the other hand, the sterile erect filaments of the alga in question (Figs. 14-15, 17) bear somewhat a resemblance to the paraphyses of *Rhodophysema* as pointed out earlier. However, those curved filaments are not specialized from fertile filaments in any respect except that they are more slender. It seems better to avoid the term paraphyses for such filaments.

*Cruoriopsis ensisae* described by Jao (1936) based on material from Massachusetts, North America, shows somewhat an affinity with this alga. *C. ensisae*, however, differs from this alga in having distinctive sori, shorter erect filaments and smaller tetrasporangia. *C. ensisae* is allied to *Rhodophysema minus*, as pointed out by Denizot (1968). The situation in *C. ensisae* regarding the nature of the vegetative portion of erect filaments is similar to *R. minus*. This character of both algae, however, has not been confirmed and so their taxonomic status remains unsolved.

*Cruoriopsis hyperborea*, which was originally described on the basis of material collected from Greenland by Rosenvinge (1910), seems to be most closely allied to this alga. According to Rosenvinge (1910), the erect filaments of *C. hyperborea* are not connected by any soft gelatinous matter as in this alga. His illustration (Rosenvinge, 1910, p. 103, Fig. 2, B) agrees well with those of this alga (Fig. 17) in this respect, which is a peculiar characteristic of the latter alga. Other essential characters such as the basal layer lacking rhizoids, being monostromatic, and the tetrasporangia produced terminally on the erect filaments and dividing cruciately strongly ally *C. hyperborea* with this alga. However, there still exist several differences between these algae. The principal distinction between *C. hyperborea* and this alga is the dimensions of the tetrasporangia. The tetrasporangia of *C. hyperborea* are 15-23 $\mu$m long and 11-13 $\mu$m in diameter (Rosenvinge, 1910), whereas those of this alga are much larger than the former, measuring 32.5-45.0 $\mu$m long and 17.5-25.0 $\mu$m in diameter. Additional differences between the two algae are as follows.

(1) The sterile erect filaments of this alga always become recurved as do the paraphyses of *Rhodophysema*, but those of *C. hyperborea* do not become so.

(2) In this alga the branching of erect filaments occurs at the upper portion (Fig. 16) as well as at the lower portion (Fig. 17), whereas that in *C. hyperborea* occurs only at the upper portion.

(3) The thallus of this alga is rather thicker than that of *C. hyperborea*. *C. hyperborea* was established on the basis of one specimen by Rosenvinge (1910), but its original characterization was confirmed by Rosenvinge (1926) and Taylor (1937) based on many specimens. Thus, it is sufficiently confirmed that *C. hyperborea* and this alga are closely allied to each other, although the spore development of the former has unfortunately not been described. The several differences mentioned above are not so much large, but they seem to distinguish the two algae as separate species within a genus.

Finally, one other alga that requires discussion is *Cruoriopsis aestuarii* described by Hollenberg (1970) on the basis of material from California. The erect filaments of *C. aestuarii* are closely but loosely adjoined and his illustration shows clearly this character (Hollenberg, 1970), which resembles those of *C. hyperborea* and the alga under discussion. However, the tetrasporangia of *C. aestuarii* are always formed laterally on the second or third cell from the base of the erect filaments, whereas those of the latter two algae are usually on the terminal end of the erect filaments or occasionally lateral. Furthermore, the erect filaments of *C. aestuarii* are gelatinous differing from the latter. These two characters make questionable the position of *C. aestuarii* in the same genus including the latter two algae, and ally the former with *Plagiospora*.

As discussed above, the alga in question has close affinity with *Cruoriopsis hyperborea*. However, the generic name, *Cruoriopsis*, should be avoided because Denizot (1968) revised that genus and transferred several species including its type species, *C. cruciata*, to the genus *Cruoriella*. At present six species of uncertain position remain in '*Cruoriopsis*'. The status of one of these, *C. hyperborea*, is now decided by comparison with the following alga. A new genus *Rhodophysemopsis* is proposed on the basis of the alga examined here and named *R. laminariae*, sp. nov. In addition, *Cruoriopsis hyperborea* is transferred to this new genus. The family including *Rhodophysemopsis* is not decided because the female gametophyte has not been observed. *Rhodophysemopsis* may belong to a family in the Cryptonemiales judging from thallus development and structure.

**Rhodophysemopsis** Masuda, gen. nov.

Plantae crustosae, noncalcareae, circulare usque ellipticae, pagina inferna omni ad substratum arte affixae, sine rhizoideis; thallus ex strato basali monostromatico et filamentis erectis multis compositus; stratum basale ex ordinibus cellularum irregulariter radiantibus compositum; filamenta erecta e cellulis strati basalis orientia, uniseriata, laxe coniuncta, simplicia, vel interdum cum ramis lateralibus, cuticula vel matrice gelatinosa non involuta; tetrasporangia in filamentis erectis plerumque terminalia, vel interdum lateralia, sorum conspicuum non formantia, cruciatim devidentia; cellulae maternae spermatangii ex cellulis terminalibus filamentorum erectorum oriundae, quaque cellula materna spermatangii duo spermatangia vel raro unum producente; carpogonia et cystocarpia ignota.

Typus generis: *Rhodophysemopsis laminariae* Masuda, sp. nov.

Plants crust-like, noncalcareous, circular to elliptical, closely attached to the substratum by the whole lower surface, without rhizoids; thallus composed of a monostromatic basal layer and many erect filaments; basal layer composed of irregularly radiating cell rows; erect filaments arising from the basal layer, uniseriate, loosely adjoined, simple or occasionally with lateral branches, not enveloped by cuticle or gelatinous matrix; tetrasporangia usually terminal on the erect filaments, or occasionally lateral, not forming a conspicuous sorus, dividing cruciately; spermatangial mother-cells originating from terminal cells of erect filaments, each spermatangial mother-cell producing two spermatangia or rarely one; carpogonia and cystocarps unknown.

The generic name is based on the seeming habit similar to *Rhodophysema*.

**Rhodophysemopsis laminariae** Masuda, sp. nov.

Plantae epiphyticae, 0.5-2.0 mm in diametro, 70-240 μm crassae in partibus fertilibus, in colore atrorubrae, molles; cellulae strati basalis 6.3-12.5 μm in diametro et 1-3 plo longiores quam latae; cellulae filamentorum erectorum 7.5-15.0 μm in diametro et 0.6-2.5 plo longiores quam latae; filamenta erecta e 1-13 cellulis; filamenta sterilia ad extremum superum recurvescentia, leviter graciliora quam filamenta tetrasporangifera; tetrasporangia ellipsoidea, 32.5-45.0 μm longa et 17.5-25.0 μm in diametro, disperse adsunt; spermatangia anguste ellipsoidea, 8-9 μm longa et 5-6 μm in diametro.

Holotypus: Specimen tetrasporangiferum, SAP 031755 (*Masuda* 14036).

Plants epiphytic, 0.5-2.0 mm in diameter, 70-240 μm thick in fertile portion, dark red in color, soft; cells of the basal layer 6.3-12.5 μm in diameter and 1-3 diameters long; cells of the erect filaments 7.5-15.0 μm in diameter and 0.6-2.5 diameters long; erect filaments composed of 1-13 cells; sterile filaments becoming recurved at the upper end, slightly slenderer than tetrasporangiferous filaments; tetrasporangia ellipsoid, 32.5-45.0 μm long and 17.5-25.0 μm in diameter, sporadically present; spermatangia narrowly ellipsoid, 8-9 μm long and 5-6 μm in diameter.

The specific epithet is formed from its habitat.

**Rhodophysemopsis hyperborea** (Rosenvinge) Masuda, comb. nov.

Basionym: *Cruoriopsis hyperborea* Rosenvinge, 1910, p. 102, Fig. 2.

## Literature cited

Chemin, E. 1937. Le dévelopment des spores chez les Rhodophycées. Revue Gén., Bot., **49**: 205-234, 300-327, 353-374, 424-448, 478-536, pls. 30-33. Denizot, M. 1968. Les Algues Floridées encroutantes (à l'exclusion des Corallinacées), Thesis, Paris. Dixon, P.S., S.N. Murray, W.N. Richardson and J.L. Scott, 1972. Life history studies in genera of the Cryptonemiales. Soc. Bot. Fr. Mémoires **1972**: 323-332. Edelstein, T. 1970. The life history of *Gloiosiphonia capillaris* (Hudson) Carmichael. Phycologia, **9**: 55-59. Fletcher, R.L. 1975. The life history of *Rhodophysema georgii* in laboratory culture. Marine Biology, **31**: 299-304. Ganesan, E.K. and J.A. West, 1975. Culture studies on the marine red alga *Rhodophysema elegans* (Cryptonemiales, Peysonneliaceae). Phycologia, **14**: 161-166. Guiry, M.D. 1974. A preliminary consideration of the taxonomic position of *Palmaria palmata* (Linnaeus) Stackhouse=*Rhodymenia palmata* (Linnaeus) Greville. J. mar. biol. Ass. U.K., **54**: 509-528. Hollenberg, G.J. 1970. Phycological notes IV, including new marine algae and new records for California. Phycologia, **9**: 61-72. —— and I.A. Abbott, 1965. New species and new combinations of marine algae from the region of Monterey, California. Can. J. Bot., **43**: 1177-1188. —— and ——, 1966. Supplement to Smith's Marine algae of the Monterey Peninsula. Stanford Univ. Press, Stanford. Inoh, S. 1947. Kaiso no Hassei. Hokuryukan, Tokyo (in Japanese). Jao, C.-C. 1936. New Rhodophyceae from Woods Hole. Bull. Torrey Bot. Club, **63**: 237-257. Kylin, H. 1944. Die Rhodophyceen der schwedischen Westküste. Lunds Univ. Årsskr. N.F., Avd. 2, **40**(2): 1-104. ——, 1956. Die Gattungen der Rhodophyceen. Gleerup. Lund. Lee, I.K. and M. Kurogi, 1968. On the antheridium formation of *Halosaccion saccatum* Kütz. and *Halosaccion firmum* (Post. et Rupr.) Rupr. Bot. Mag. Tokyo, **81**: 452-458. Masuda, M. and M. Ohta, 1975. The life history of *Rhodophysema georgii* Batters (Rhodophyta, Cryptonemiales). Journ. Jap. Bot., **50**: 1-10. Rosenvinge, L.K., 1910. On the marine algae from north-east Greenland. Medd. om Grønland. **43**: 93-133. ——, 1917. The marine algae of Denmark. Part II. Rhodophyceae II (Cryptonemiales). Kgl. Danske Vidensk. Selsk. Skr. 7: 155-283, pls. 3-4. ——, 1926. Marine algae collected by Dr. H.G. Simmons during the 2nd Norwegian Arctic expedition in 1898-1902. Report of the second Norwegian Arctic expedition in the "Fram" 1898-1902, **37**: 1-40. South, G.R., R.G. Hooper and L.M. Irvine, 1972. The life history of *Turnerella pennyi* (Harv.) Schmitz. Br. Phycol. J., **7**: 221-233. Stafleu, F.A. 1972. International Code of Botanical Nomenclature adopted by the Eleventh International Botanical Congress, Seattle, August 1969. Regnum Vegetabile, **82**: 1-426. Taylor, W.R. 1937. Marine algae of the northeastern coast of North America. Univ. Michigan Press, Ann Arbor. Tokida, J. 1934. Phycological observation I. Trans. Sapporo Nat. Hist. Soc. **13**: 196-202. pl. 8. West, J.A. 1972. The life history of *Petrocelis franciscana*. Br. Phycol. J., **7**: 299-308.

* * * *

北海道花咲でガツガラコンブ *Laminaria coriacea* ので茎状部に着生していた興味深い殻状の紅藻を採集した。本藻は二原細胞型に似た胞子の発生様式で，一層の基部組織を形成する。基部組織の細胞は仮根を発出することがなく，上部より直立糸を形成する。直立糸は密集して形成されるが共通のクチクラ層あるいはゼラチン質によって包まれないで，互いにゆるく接着しているにすぎない。本藻はこれらの形質の他に四分胞子囊の形成方法，分裂様式において *Cruoriopsis hyperborea* Rosenvinge に良く似ているが，現在までに記載された他の種とは極端に異なる。*C. hyperborea* とは，四分胞子囊が非常に大きいこと，sterile filaments が反曲すること，直立糸が下部においても分岐すること，藻体が厚いことなどで本藻は区別される。*Cruoriopsis* はその type species が *Cruoriella* に移されたため，属名として使用できない。そこで両種を含む新属フチトリベニモドキ属（新称）*Rhodophysemopsis*, gen. nov. を設立し，本種を新種フチトリベニモドキ（新称）*R. laminariae*, sp. nov. として記載し，*C. hyperborea* を新属に移した。

---

□金井弘夫：**全国地名索引**　I. 東北地方　pp. 253，全国地名索引刊行会国立科学博物館内新宿区百人町，東京（1976），2,000円 送料 350円。標本をみる時，標本を引用する時，その地名がどこであるかを知るのは大変である。ことに近年市町村合併が進行し，大部分の地名が変ってしまったからなお更である。著者もその一人で，それを打解しようと座標を新たに考え（本誌 **47**: 215-221 ('74) 参照），それを具体化したものが本書である。

5万分の1図を基準とするが，その16分の1を座標で示す。それには経緯度を用い8桁の数字で表わす。たとえば一の目潟は 393396-43 という風にする。こうして一先ず東北地方の地名を拾って五十音順に排列したのである。但し市町村名は入っていない。これは中々の大変な仕事で，その骨折りは情報機器を使うとはいっても大した量である。著者の努力に謝意を表する。

たとえば□□国有林というのを引くと24個所でてくるが，東北地方としてはひどく少なく思う。これは5万分の地図には必らずしも全部載っていないからであろう。清水田（スズデン），施田（ナモミダ）などの難読地名を拾うのは，著者には申訳ないが楽しい。新庄（シンジョウ）駅はでてくるが肝心の新庄市はでて来ないとか尾瀬ヶ原は温泉だけしかでないなどは考えてほしいところである。

何はともあれ，この重大で労多い仕事にとり組まれた著者に深い敬意と篤い謝意を表する次第である。

（前川文夫）